Pb nanoparticles produced by ion implantation in Si and Al

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Pb nanoparticles are synthesized by high fluence ion implantation in Si(100) wafers and in single crystalline epitaxial Al films and subsequent annealing. Their size (5-20 nm) and size distribution was tuned by varying the implantation fluence and temperature, as well as the annealing temperature and time. The size and structural properties were characterized by Rutherford backscattering spectrometry, x-ray diffraction, small angle x-ray scattering and transmission electron microscopy. Different growth regimes could be distinguished and identified by the different scaling behaviors of the average particle radius with the implantation parameters. The crystal structure of the Pb nanoparticles and their epitaxial orientation and strain in the Si and Al matrix are studied in detail.
The superconducting properties of the Al films with implanted Pb nanoparticles are investigated by electrical transport measurements for different volume ratio's of Pb nanoparticles in the Al matrix. The superconducting critical temperature of this hybrid system was found to increase with growing volume ratio of the Pb nanoparticles in a way consistent with superconducting proximity effect models for bilayer systems.
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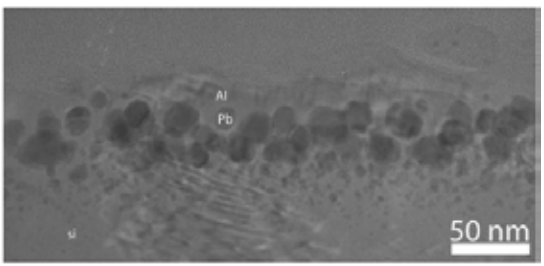

Fig. 1: Cross-sectional TEM picture of Pb nanoparticles (10-25 nm) embedded in an Al-film.